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INTRODUCTION.

This REVIEW treats generally the meteorological conditions of the United States and Canada for April, 1888, and is based upon the reports of regular and voluntary observers of both countries. Descriptions of the storms that occurred over the north Atlantic Ocean are also given, and their approximate paths shown on chart i, on which also appears the distribution of field-ice and the limits of fog-belts west of the fortieth meridian.

The marked departures from the normal atmospheric pressure for this month is worthy of mention, the pressure being decidedly above the normal in all parts of the country, except in southern California.

The rainfall was largely deficient on the Pacific coast, in the central valleys, south Atlantic and Gulf states; it was much above the average in the Rio Grande valley and in the adjacent portions of the southern slope and central Texas.

The month was warmer than the average in the Southern States, Rocky Mountain districts, and on the Pacific coast, the mean temperatures ranging from 2° above the normal in the Gulf States to more than 6° above in the Rocky Mountain regions; it was slightly colder than the average from the upper Mississippi valley eastward to the New England coast.

In this REVIEW appears the first summary for the season of 1888 of observations of temperatures and rainfall in the cotton

regions, a comparison of which with means of April of former years shows, in general, the same features as exhibited by reports from the regular Signal Service stations, viz., high mean temperatures, and, with the exception of the district of Galveston, marked deficiencies of rainfall.

In the preparation of this REVIEW the following data, received up to May 20, 1888, have been used, viz., the regular tri-daily weather-charts, containing data of simultaneous observations taken at 133 Signal Service stations and 21 Canadian stations, as telegraphed to this office; 181 monthly journals and 179 monthly means from the former and 21 monthly means from the latter: 319 monthly registers from voluntary observers; 60 monthly registers from United States Army post surgeons; marine records; international simultaneous observations; marine reports through the co-operation of the Hydrographic Office, United States Navy, and the "New York Herald Weather Service;" monthly weather reports from the local weather services of Alabama, Arkansas, Colorado, Illinois, Indiana, Kansas, Louisiana, Michigan, Minnesota, Mississippi, Missouri, Nebraska, Nevada, New England, New Jersey, North Carolina, Ohio, Oregon, Pennsylvania, South Carolina, and Tennessee, and the Central Pacific Railway Company; trustworthy newspaper extracts, and special reports.

ATMOSPHERIC PRESSURE (expressed in inches and hundredths).

The distribution of mean pressure for April 1888, determined from the tri-daily telegraphic observations of the Signal Service, is shown by isobarometric lines on chart ii, from which it will be seen that the mean pressure for this month is greatest over a region extending from the Great Lakes southward to the Atlantic and Gulf coasts, the means generally ranging from 30.15 to 30.17. The lowest barometric means occur in the Rocky Mountain districts, where they are below 30.0 at most stations.

The departures from the normal pressure at the various Signal Service stations are given in the table of miscellaneous meteorological data. The pressure is nowhere below the normal and there is, comparatively, but a small area, viz., central and southern California, over which it is not above the normal. As it seldom occurs that the mean pressure of a month exceeds the normal over so much of the United States as is the case this month, this feature, together with the marked excess over the whole territory east of the Rocky Mountains, makes the month, with regard to mean pressure, an exceptional one. Over nearly all of the region east of the Rocky Mountains the departures amount to from .10 to .17 and there is but a limited area, viz., California and portions of Arizona and New Mexico, in which they fall below .05.

Compared with the preceding month a deficiency is shown over the region between the Mississippi River and Rocky

Mountains, the departures being less than .05 except in Montana, Dakota and Minnesota where they range from .05 to .13. East of the Mississippi River, in the northern and central plateau, and thence westward to the Pacific, the mean pressure of April is greater than that for March, the excess amounting to .10 or slightly more on both the north Pacific and New England coasts.

BAROMETRIC RANGES.

The monthly barometric ranges at the various Signal Service stations are also given in the table of miscellaneous meteorological data. The ranges, as usual, conform to the general rule; that is, they increase with the latitude and decrease slightly, though somewhat irregularly, with increasing longitude. In the states bordering on the Atlantic the extreme ranges are: .29 at Key West, Fla. and 1.03 at Albany, N. Y.; between the eighty-second and ninety-second meridians, .37 at New Orleans, La., and 1.08 at Alpena, Mich.; between the Mississippi River and Rocky Mountains, .39 at Galveston, Tex., and 1.42 at Fort Totten, Dak.; plateau regions, .43 at Prescott and Yuma, Ariz., and .97 at Fort Bridger, Wyo.; Pacific coast, .35 at Los Angeles and San Diego, Cal., and .76 at Port Angeles, Wash. The ranges for April, 1888, are about normal in the southern portions of the country, on the Pacific coast, and in the Lake region. In the Missouri Valley they exceed the normal from .20 to .40, while in New England they are from .10 to .20 below the normal.

AREAS OF HIGH PRESSURE.

During the month of April, 1888, nine well-defined areas of high pressure have passed across the territory covered by the tri-daily weather charts. Eight of these originated in the Northwest Territory, and one on the north Pacific coast. The general direction of movement was to the southeast, and all but two reached the Atlantic coast.

The following table shows, for each area, the latitude and longitude in which its centre was first and last observed, the highest observed barometer readings, and the average velocity in miles per hour:

Number of area.	First observed.		Last observed.		Highest observed barometer reading.	Average hourly velocity.
	Lat. N.	Long. W.	Lat. N.	Long. W.		
I.....	46 50	103 50	40 20	72 50	Inches. 30.42	Miles. 28.1
II.....	42 00	124 00	38 10	73 10	30.56	33.4
III.....	50 10	100 00	35 00	76 00	30.66	34.5
IV.....	47 15	100 00	37 45	81 00	30.26	34.0
V.....	51 00	100 00	36 20	73 25	30.44	33.2
VI.....	51 00	114 00	38 50	88 30	30.58	50.8
VII.....	49 45	103 00	33 00	81 20	30.46	23.3
VIII.....	50 20	101 50	35 00	74 45	30.64	31.8
IX.....	52 00	111 50	51 45	90 00	30.94	39.6

Average rate of progress, 34.3 miles per hour.

I.—This area of high pressure developed over northern Dakota on the night of the 1st, when the highest pressure was not more than 0.1 above the normal. On reaching the Lake region the pressure at the centre began to increase and when last observed was 30.42 along the coasts of Connecticut and New Jersey, on the morning of the 4th. Light winds and fair weather attended the area throughout its course. A fall in temperature of from 10° to 20° in twenty-four hours occurred over the Ohio Valley and the Lake region on the morning of the 3d, when the temperature at nearly all stations to the north of the Ohio River was below freezing. A sharp fall in temperature occurred over the middle Atlantic states, but did not cause frosts. The lowest temperature of the month occurred over eastern Montana and northern Dakota on the 1st and 2d.

II.—The morning chart of the 4th indicated the advance eastward from the Pacific of an area of high pressure which was apparently central on the north Pacific coast at 10 p. m. of the 4th. The area moved eastward, maintaining a central pressure near 30.2 until central over the lower Missouri valley, when the pressure began to rise. At 7 a. m. of the 6th a second centre had developed on the northern border of the area. On the following morning the two centres had combined in one situated to the north of Lake Superior, and the central pressure had increased to 30.56 at Prince Arthur's Landing, the highest reported during the existence of the area. From this position it moved to the southeast and passed to the ocean from the coast of the middle Atlantic states on the afternoon of the 9th. Generally fair weather attended the area, though light local rains were reported from a few stations located on its outer limits. It was accompanied by a fall in temperature, amounting to 10° over the northern and middle plateau districts, 20° over the northern and middle slopes of the Rocky Mountains and the Missouri Valley, and ranging from 20° to 30° in twenty-four hours over the Ohio Valley and the Lake region. The lowest temperature of the month over eastern Minnesota, northern and eastern Michigan, the lower lake region, Pennsylvania, New York, and New England states occurred under the influence of this area.

III.—This area was first observed to the north of Dakota, where it was central on the morning of the 11th, and extended southeastward to the Gulf of Mexico. Light winds and fair weather prevailed throughout the United States, excepting over the lower lake region and along the Atlantic coast, where rain occurred, due to the influence of an area of low pressure then central north of Lake Ontario. The area moved nearly south until central over Kansas, where the movement was more to the eastward. Before reaching the coast the area broke up

into several portions, one central in Texas, another central in the eastern Gulf states, and still another central on the coast of North Carolina, all disappearing by a gradual decrease of pressure. Fair weather prevailed in all parts of the area. The fall in temperature was very light, amounting usually to about 10°, but, in rare instances, reaching 20° in twenty-four hours.

IV.—This area was central in Dakota on the afternoon of the 13th. It moved in a southeasterly direction, disappearing from the charts after 7 a. m. of the 15th. It was attended by light winds and fair weather, with only a slight fall in temperature.

V.—This area was central in Manitoba on the afternoon of the 15th, the pressure at the centre being but slightly above the normal. It moved to the southeast during the 16th and 17th over the Lake region and the middle Atlantic states, the pressure reaching 30.44, the highest attained during its existence. Light rains occurred within the eastern limits, probably due to an area of low pressure then in advance, and also within the limits of this area of high pressure, probably due to the area of low pressure which followed it. No dangerous winds were reported. The fall in temperature was light, being greatest in the lower Missouri valley, Illinois, Indiana, and along the coast of the south Atlantic states, where it amounted to 20° in twenty-four hours.

VI.—The 10 p. m. chart of the 17th shows the advance isobars of an area of high pressure which apparently moved southeastward from the north Pacific. Its centre was first located within the region of observation on the morning of the 17th. It moved rapidly to the southeast with decreasing pressure and disappeared from the charts while over Illinois on the afternoon of the 18th, having united with the following area which was then central north of Dakota. It was accompanied by light winds and fair weather, excepting in the eastern limits of the area, where light rains occurred, probably due to the influence of an area of low pressure hereafter described as area number vi. There was a fall of from 10° to 20° in temperature over the northern and middle slopes of the Rocky Mountains and the Missouri Valley. At 3 p. m. of the 17th the temperature was 30° lower over Kansas than at the same time on the preceding day, a fall of 24° in the previous eight hours being shown at Leavenworth.

VII.—The 10 p. m. chart of the 18th shows the atmospheric pressure everywhere in the United States to the east of the Mountains to be above the normal, excepting over the New England States, where it was only slightly below. The area was central in northern Dakota. It moved slowly and irregularly southeastward and passed off the coast of the south Atlantic states after the 7 a. m. observation of the 22d, the central pressure having steadily declined until it was slightly above the normal. Light rains within the eastern limits of the area were reported over the lower lake region, the Ohio Valley, and along the coast of the south Atlantic and east Gulf states. In all other districts within the area fair weather, with light winds, prevailed, excepting over the lower lakes on the night of the 18th, where some stations reported maximum wind-velocities of thirty-five miles. The fall in temperature was less than 10° in twenty-four hours over a large portion of the country traversed by the area, but in a few instances the fall amounted to 20° in twenty-four hours. The minimum temperatures of the month occurred on the 20th, 21st, and 22d over the Missouri Valley, Kentucky, Tennessee, Arkansas, and the eastern Gulf states.

VIII.—The centre of this area of high pressure appeared north of Dakota on the morning of the 23d, and the area extended from the Rocky Mountains eastward to the Appalachian Mountains, and as far south as Arkansas. The area moved to the southeastward and was central over Lake Superior on the morning of the 24th, when it extended over all of the United States east of the Rocky Mountains. The pressure at the centre slowly increased as it approached the coast to 30.64, the highest reported. From 10 p. m. of the 26th to 10

p. m. of the 27th the centre was apparently located on the coast near Wilmington, N. C., after which the pressure began to decrease, and at 3 p. m. of the 28th the area had entirely disappeared from the charts. Fair weather and light winds prevailed within its limits, excepting in a few instances where light and heavy local rains were reported, and during the 25th and 26th, when winds were high over the Florida Peninsula and on the coast of Texas. At 3 p. m. of the 23d the fall in temperature over the middle slope of the Rocky Mountains, Missouri, and the northern part of Arkansas ranged from 20° to 30° ; along the coast of the south Atlantic states on the afternoon of the 24th the fall in temperature amounted to 20° , while in all other localities it amounted to 10° or less in twenty-four hours. The minimum temperature of the month occurred at a number of stations in Virginia and North and South Carolina on the 25th and 26th.

IX.—This area of high pressure appears to the north of Montana on the 3 p. m. chart of the 27th. It moved eastward, at the same time extending rapidly southward along the eastern slope of the Rocky Mountains as far as Texas, the pressure at the most northerly station being 30.94. After 10 p. m. of the 28th the movement of the area was apparently to the northeast, passing beyond the region of observation. There was a fall of temperature on the afternoon of the 29th at Chicago, Ill., and Detroit, Mich., of 44° in twenty-four hours, but generally the fall amounted to 20° or less. At 7 a. m. of the 29th and 30th the temperature reached the freezing point and below over Montana, Wyoming, Colorado, Dakota, Nebraska, Kansas, Minnesota, western Iowa, northern Wisconsin, and northern Michigan, and the minimum temperatures of the month occurred over southern Wyoming, western Nebraska, western Kansas, Colorado, New Mexico, Indian Territory, and Texas.

AREAS OF LOW PRESSURE.

Nine areas of low pressure have been traced during April across the territory occupied by stations of observation. Of this number, seven were first observed west of the one hundred and seventh meridian and north of the fortieth parallel; one developed in New Mexico, and one appeared off the coast of New England. The tracks followed by the centre of each area, as determined from tri-daily observations, are shown on chart i. That described as number ii was the severest storm of the month.

The following table shows the latitude and longitude in which each area was first and last observed, the lowest pressure observed within each area, and the average velocity in miles per hour:

Number of area.	First observed.		Last observed.		Lowest observed barometer reading.	Average hourly velocity.
	Lat. N.	Long. W.	Lat. N.	Long. W.		
I.	49 00	123 00	45 00	60 30	Inches.	Miles.
II.	48 45	123 00	48 20	67 00	29.40	68.8
III.	33 00	113 00	44 00	62 35	29.39	41.7
IV.	33 00	113 40	46 10	58 50	29.42	26.5
V.	50 45	107 00	37 20	75 00	29.56	26.6
VI.	50 45	112 40	49 40	65 20	29.72	40.1
VII.	50 35	110 00	45 00	60 00	29.52	39.7
VIII.	40 30	67 50	48 10	64 50	29.34	36.0
IX.	49 00	118 00	52 00	95 45	29.46	18.8
					29.32	24.6

Average rate of progress, 35.9 miles per hour.

I.—The tri-daily charts of the last two days of the preceding month indicated the advance eastward from the north Pacific of an area of low pressure, which at 10 p. m. of March 31st was apparently central in northwest Washington, and extended southeastward to Texas. At the following observation the depression had moved southeastward and was central in the Missouri Valley. After 10 p. m. of April 1st the area, which had become very much elongated in a northeast and southwest direction, divided into two portions, one remaining central over Texas and gradually disappearing by increase of pressure, the other moving to the northeast with decreasing pressure, and passing beyond the region of observation after 10 p. m. of the

2d. At 10 p. m. of the 1st light rain began over the lower lake region, New York, and the New England States, continuing during the 2d. Slightly higher temperature prevailed.

II.—This depression apparently moved southeastward from the north Pacific Ocean. The pressure at the centre steadily decreased until the lowest point, 29.30, was reached at Fort Sully, Dak., at 3 p. m. of the 4th, after which it rapidly increased to 29.6 which was maintained with slight changes. Light rains occurred over the Pacific coast regions on the 3d and 4th, but no rain occurred within the area over Rocky Mountain districts. Precipitation began in the eastern quadrants of the storm on the afternoon of the 4th over the upper Mississippi valley and the Lake region, and became general within the area on the night of the 5th over the middle Atlantic and New England states. The depression caused high winds over the eastern slope of the Rocky Mountains on the 4th, and severe southeasterly, changing to westerly and northwesterly, gales over the Lake region and along the coast of the middle Atlantic states on the 5th and 6th. The rise in temperature attending the depression was greatest over the Ohio Valley on the morning of the 5th, and over the lower lake region on the afternoon of the 5th, when it exceeded 20° , but in other districts the rise rarely amounted to 20° , and usually was 10° , or less, in twenty-four hours.

III.—Two areas of low pressure appear on the 10 p. m. chart of the 7th, one to the north of Montana, the other in southern New Mexico. The first moved eastward, its centre remaining to the northward of the region of observation; the second moved northeast, and at 3 p. m. of the 9th both had united in one area, nearly circular in shape, central over the lower Missouri valley. The central pressure decreased over the Lake region to 29.4 and increased to 29.9 over the New England States. Rain became general within the area at 10 p. m. of the 8th and continued. Severe gales prevailed over the Lake region from the 9th to 11th, and along the coast of the middle Atlantic and New England states on the 10th and 11th. The increase of temperature was slight, amounting usually to about 10° and rarely to as much as 20° in twenty-four hours.

IV.—This area was first observed on the afternoon of the 11th, extending southward over Montana. The pressure at the most northerly stations of observation was nearly normal. The area moved to the southeast with slowly decreasing pressure, its centre remaining to the northward of the region of observation until the morning of the 14th, when it was central over the lower lakes. On reaching the coast of the New England States the direction changed to the northeast, and when last observed off the coast of Nova Scotia the pressure had declined to 29.56, the lowest observed during the existence of the area. Rain became general on the night of the 14th over a small area immediately about the centre of the storm, passing over in turn the lower lake region, New York, and the New England States. Moderate gales occurred over the Lakes on the 13th and 14th, and at a few stations on the coast on the morning of the 15th.

V.—This depression developed in the Northwest Territory, and moved southeast to the coast of Virginia. It displayed but feeble energy, the pressure being only slightly below the normal. Light winds and fair weather prevailed within its limits until the afternoon of the 15th when light rain began in the northern quadrants over the lower lake region and the northern half of the middle Atlantic states.

VI.—An area of low pressure originated in the northern Rocky Mountain districts on the 15th and moved to the southeastward, the pressure increasing slowly until near the normal. While over the lower Missouri valley the direction of movement changed to the northeast, and it passed to the Gulf of Saint Lawrence on the afternoon of the 19th, the pressure having decreased to 29.52. Winds were brisk over the northern and middle slopes of the Rocky Mountains on the 15th and 16th, but decreased in force over the Lakes. Fair weather prevailed until the night of the 16th, when light rains began. The increase of temperature was not marked, amounting usually to about 10° in twenty-four hours.

VII.—This storm was of feeble energy. It was first observed in the Northwest Territory and was central in northern Montana on the morning of the 20th. Rain began in the northern quadrants of the storm on the afternoon of the 22d. Winds were light, excepting on the coast of North Carolina, where maximum velocities of thirty-five miles were reported. The maximum temperatures of the month were reported on the 21st and 22d from stations in Wyoming, south Dakota, Nebraska, Kansas, Colorado, and Utah, and on the 19th and 20th from stations in Washington and Oregon.

VIII.—On the 3 p. m. chart of the 20th an area of low pressure is shown to be central in the Atlantic east of Massachusetts. It moved in a direction slightly to the east of north across the Maritime Provinces of Canada, the pressure de-

creasing to 29.46 when last observed at 7 a. m. of the 22d. It was attended by light winds and rain or snow.

IX.—This depression probably moved southeastward from the north Pacific. Its direction of movement changed near the one hundred and seventh meridian. The area was stationary near Fort Buford, Dak., from 10 p. m. of the 24th for twenty-four hours, when the pressure declined to 29.32. It disappeared to the northeast after 3 p. m. of the 26th. Generally fair weather prevailed within the area until the night of the 25th, when light rains occurred over Montana and Dakota. High winds were reported over Nebraska, Dakota, and northern Minnesota during the 24th and 25th. Under the influence of this area the maximum temperatures occurred over eastern Montana, northern Dakota, and Minnesota.

NORTH ATLANTIC STORMS FOR APRIL, 1888.

[Pressure in inches and millimetres; wind-force by Beaufort scale.]

The paths of the depressions that appeared over the north Atlantic Ocean during April, 1888, have been determined from international simultaneous observations by captains of ocean steamships and sailing vessels, received through the co-operation of the Hydrographic Office, Navy Department, and the "New York Herald Weather Service."

Of the ten depressions traced, seven originated west of the fiftieth meridian, and pursued east to northeast tracks over Newfoundland or the Grand Banks; one advanced northwestward from the vicinity of the Azores; one moved eastward over the Bay of Biscay, and one first appeared over mid-ocean near the fifty-fifth parallel, and thence passed eastward to the British Isles. The month opened with unsettled weather and fresh to strong gales between the thirtieth and sixtieth meridians, attending the presence of two areas of low pressure, one of which was located over the Banks of Newfoundland, and the other to the northward of the Azores. A third depression was apparently central off the coast of Portugal. Over the British Isles and off the American coast south of the fortieth parallel the pressure was relatively high. During the balance of the first decade the weather continued unsettled over the western portion of the ocean, with marked barometric fluctuations. During this period the pressure continued generally high east of the thirtieth meridian. From the 10th to the 20th, inclusive, three important storms appeared, one of which traversed the ocean from coast to coast; one passed from the Banks of Newfoundland to the eighteenth meridian, and one, of tropical or subtropical origin, advanced from the vicinity of Bermuda to Newfoundland, and thence moved northeastward and disappeared over mid-ocean. During the third decade high barometer and generally fair weather prevailed over mid-ocean until the 29th, during which and the following date fresh to strong gales occurred. Over the British Isles and the ocean to the southward the last ten days of April constituted the stormy period of the month, although from the 25th to the 27th, inclusive, the barometer was high in that region. From the 20th to the 24th the weather was unsettled west of the fiftieth meridian, after which fair weather and high barometer prevailed until the 28th, when the advance north-northeastward of a depression of small energy from near Bermuda caused lower pressure and moderate gales.

In April, 1887, eleven depressions were traced, the tracks predominating to the southward and southeastward of Nova Scotia and Newfoundland. But one depression was traced from American waters to the European coast. The general character of the weather over the ocean was very severe, and gales of hurricane force were encountered off the coast of the United States during the first five days of the month. From the 12th to the 16th, inclusive, storms of exceptional violence occurred over, and to the eastward of, the Banks of Newfoundland. During the last decade of the month the weather conditions in the trans-Atlantic routes were more settled, although

strong gales were experienced over the western portion of the ocean from the 26th to the 29th.

As compared with the corresponding month of previous years the storms of April, 1888, were deficient in number and energy.

In the following descriptions of the depressions traced, positions are given in degrees, latitude and longitude, except in cases where twenty-five to thirty-five minutes are cited, when they are shown in degrees and half degrees:

1.—This depression was central on the 1st over the southeastern part of the Banks of Newfoundland, whence it had advanced from the westward. In this position barometric pressure below 29.50 (749.3) was shown, and moderate to fresh gales prevailed. By the 2d the centre of depression had moved northeast to the thirty-ninth meridian, with an increase in pressure of about .20 inch, after which it apparently recurved westward under the influence of a depression passing northeast over Newfoundland, and an area of high pressure overlying the ocean east of the thirtieth meridian.

2.—This was a well-defined storm of small energy which moved northwest from the vicinity of the Azores during the 1st and united with depression number 1 by the 2d.

3.—This depression was a continuation of land low-area number i which traversed the North American continent and passed eastward from Nova Scotia during the 2d. On the morning of the 3d the depression was central off the west coast of Newfoundland, with pressure below 29.60 (751.8), from which position it moved northeast beyond the region of observation.

4.—This depression was the continuation of land low-area number ii which traversed the American continent and advanced northeast over the Gulf of Saint Lawrence during the 6th. On the 7th the storm was central near Anticosti Island, and thence advanced over the ocean north of Newfoundland.

5.—This depression first appeared on the 10th off the east edge of the Banks of Newfoundland, with pressure about 29.70 (754.4), whence it advanced east-northeast to the westward of the British Isles by the 15th, attended by a gradual decrease in central pressure and gales of increasing energy. Subsequent to the 15th the storm-centre recurved south and west and united with depression number 6, which had followed closely in its wake.

6.—This depression is first charted southwest of Nova Scotia under date of the 13th, whence it moved rapidly east-northeast to the north of Ireland by the 17th, accompanied after the 14th by disturbances of pronounced strength. By the 18th the centre of depression had recurved southward over Ireland, with pressure falling below 29.50 (749.3), from which position it moved eastward beyond the region of marine observations.

7.—The pressure of this depression to the southward of Bermuda was indicated by reports of the 14th. By the 15th the storm-centre had moved northward to the fortieth parallel, and during the 16th and 17th remained nearly stationary